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ABSTRACT

Changes in the distribution of job skills in the U.S. economy between 1960 and 1976 are examined in this document. The research assesses the effects of changes both in the distribution of employment among different occupations and in the skill requirements of individual occupations. Estimates of the latter component are based on two editions of the "Dictionary of Occupational Titles," the third edition (issued in 1965) and the fourth edition (issued in 1977). The results indicate that the general skill requirements of jobs have changed little over the past decade and a half, a period of growth and technological development when the supply of skilled labor increased dramatically. (Author/PGD)

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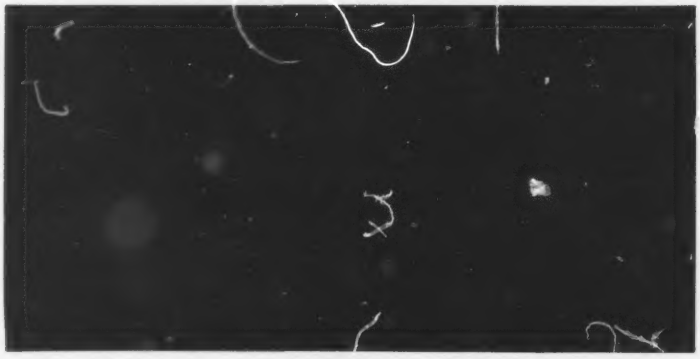

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THE CHANGING SKILL REQUIREMENTS OF JOBS IN THE U.S. ECONOMY

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September 1979

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THE CHANGING SKILL REQUIREMENTS OF JOBS IN THE U.S. ECONOMY

Abstract

This research examines changes in the distribution of job skills in the U.S. economy between 1960 and 1976. The effects of two factors are assessed: 1) changes in the distribution of employment among different occupations, and 2) changes in the skill requirements of individual occupations. Estimates of the latter component are based on two editions of the Dictionary of Occupational Titles, the 3rd edition issued in 1965 and the 4th edition issued in 1977. The results indicate that while changes in the distribution of employment has favored more skilled jobs, revisions in the DOT suggest that the overall distribution of skill levels has actually narrowed during this period.

INTRODUCTION

In conducting labor market research, economists and sociologists often focus on the earnings and other characteristics of individuals in the labor market. Less attention is directed to the characteristics of jobs, particularly skill requirements. While the notion of skills is not new in labor market research, it is usually associated with individuals and not jobs. This focus arises from the neoclassical view of the labor market which forms the basis of so much analysis. According to this view, skills are embodied in individuals in the form of "human capital."[1] Earnings are said to reflect the marginal products of individuals since it is assumed that firms effectively utilize the skills (human capital) of the work force through substitution among workers and between labor and capital.

Yet the idea of skill requirements being associated with jobs has a conceptual basis as well. In Thurow's "job competition" view of the labor market, marginal products are associated with jobs and not individuals.[2] Workers must attain a certain skill level in order to perform the tasks and achieve the marginal products associated with their jobs. In this view workers may actually possess more skills than are necessary to adequately perform the tasks of their respective jobs. Other views of the labor market also endorse the notion of job skills. Screening theory implies that job tasks may not be tied to the skills of the work force since employers base their hiring requirements on the available supply of skilled (educated) labor.[3] Within a Marxist framework, Braverman

argues that capitalist production fragments job tasks into simpler and more routine parts over time, requiring a less skilled work force.[4]

In addition to its theoretical importance, the study of job skill requirements is useful in addressing policy issues. Measuring the skill requirements of jobs serves as one means of assessing the demand for skilled labor. By contrasting the skill content of jobs in the economy with the skills possessed by the labor force, policy makers get some indication of how well the supply of skilled labor is keeping abreast of available jobs. The recent debate on the economic decline of college graduates illustrates the usefulness of this approach.[5]

Jobs skills, especially of a general nature, are often acquired in school. Except for the existence of occasional shortages, most observers view the educational system as a highly effective vehicle for producing the skills required to maintain the growth of the economy. Even in the 1960s, it appeared that the increasing supply of college educated workers entering the labor market simply met the rising demand for skilled labor. But in recent years the supply of skilled labor may have outstripped demand. Some critics charge that many college graduates must now accept positions formerly held by high school graduates.[6] Other observers claim, however, that such upgrading is necessary because of technological advances that require a more skilled labor force.[7] Yet little evidence exists to support either claim.

The research reported in this paper supplies evidence on the changing skill requirements of jobs in the U.S. economy. Specifically, the research addresses the following questions:

-Has the overall skill content of jobs increased, remained steady, or decreased in recent years?

-What factors have contributed to any observed change? In particular, what has been the effect of: 1) changes in the distribution of employment among different occupations, and 2) changes in the skill requirements of particular occupations?

The research builds upon previous work, yet differs markedly. Other researchers have assessed the overall skill level of jobs in the economy and have examined changes over time.[8] But most research accounts only for the changes in the distribution of employment and not changes in the skill requirements of particular jobs. While employment patterns are no doubt important in affecting the overall demand for skilled labor, it is equally important to determine whether the skill requirements of jobs themselves are changing. This research attempts to make such an assessment.

The remainder of the paper is divided into three sections. In the next section I outline the methodology of this study. The following section contains the empirical results. In the last section I discuss the implications of the empirical findings and make some suggestions for further research in this area.

METHODOLOGY

The conceptual framework of this research is based upon the assumption that the skill requirements of jobs are in some way specifiable and measureable. That is, I assume that there is a minimum or average skill requirement associated with every job in the economy. A worker holding

a particular job must attain the skill level associated with that job in order to perform the tasks of the job adequately. In reality, it is likely that for some tasks the skill requirements of a job are not rigidly fixed, and therefore change with the qualifications (skills) of the worker holding the job.[9] But it also is likely that there is some rigidity in this process and that employers in the short-run do not change the tasks of the job in accordance with the skills of the worker.[10] It is this notion of approximately fixed skill requirements which forms the basis for this research.

The Models. The empirical task is to estimate the aggregate distribution of skill requirements within the U.S. economy at two points in time. Each estimate requires information on the skill requirements of individual jobs as well as the distribution of jobs within the economy. With the two independent estimates of the skill requirements for particular jobs, it is possible to disaggregate changes in the overall distribution of skills into two components: 1) those arising from changes in the distribution of employment among jobs, and 2) those arising from changes in the skill requirements of individual jobs. The latter component is particularly important, since it shows the effects of technological changes on the tasks and skill levels of jobs. The first component can be further divided into changes resulting from shifts in employment among major occupation groups (such as professional/technical jobs) and shifts within major occupation groups.

Let S_{ijk} represent the probability of someone holding job k in occupation group j that requires a skill level i. The sum of these

probabilities across all skill levels equals unity:

$$\sum_{i=1}^{A} S_{ijk} = S_{\cdot jk} = 1 \ , \qquad (1)$$

where A is the number of discrete skill levels. Let $N_{jk}^{t_1}$ represent the number of people holding job k within occupation j at time t_1.

Using this information we can calculate the distribution of skill levels <u>within</u> major occupation groups at two points in time (t_1 and t_2) using two separate estimates of skill requirements (S^1 and S^2). First, the probability that someone employed in occupation group j at time t_1 holds a job requiring skill level i (based on skill estimate 1) is:

$$S_{ij.}^{t_1:1} = \frac{\sum_{k=1}^{C_j} N_{jk}^{t_1} S_{ijk}^{1}}{\sum_{k=1}^{C_j} N_{jk}^{t_1}} \ , \qquad (2)$$

where C_j represents the number of different individual jobs in occupation group j. Similarly, using the same estimate of individual skill requirements (S_{ijk}^1) for t_2 yields:

$$S_{ij.}^{t_2:1} = \frac{\sum_{k=1}^{C_j} N_{jk}^{t_2} S_{ijk}^{1}}{\sum_{k=1}^{C_j} N_{jk}^{t_2}} \ . \qquad (3)$$

Finally, using a different estimate of individual skill requirements (S_{ijk}^2) for time t_2 yields:

$$S_{ij.}^{t_2:2} = \frac{\sum_{k=1}^{C_j} N_{jk}^{t_2} S_{ijk}^{2}}{\sum_{k=1}^{C_j} N_{jk}^{t_2}} \ . \qquad (4)$$

Differences between (2) and (3) reflect changes in the distribution of employment within each occupation group. Differences between (3) and (4) reflect changes in the skill requirements of individual jobs within each occupation group.

Equations (2) - (4) can then be used to produce estimates of the aggregate distribution of skill levels at two points in time. First, using the first estimate of individual skill levels for time t_1 yields:

$$S_{i\cdot\cdot}^{t_1:1} = \frac{\sum_{j=1}^{B} N_{j\cdot}^{t_1} S_{ij\cdot}^{t_1:1}}{\sum_{j=1}^{B} N_{j\cdot}^{t_1}} , \tag{5}$$

where $N_{j\cdot}^{t_1} = \sum_{k=1}^{C_j} N_{jk}^{t_1}$ (6)

represents the number of people holding jobs in occupation group j and B represents the number of occupation groups. Similarly, for time t_2 and skill estimate 2, we have:

$$S_{i\cdot\cdot}^{t_2:2} = \frac{\sum_{j=1}^{B} N_{j\cdot}^{t_2} S_{ij\cdot}^{t_2:2}}{\sum_{j=1}^{B} N_{j\cdot}^{t_2}} . \tag{7}$$

Two other estimates of aggregate skill distributions can also be produced. First, assuming the same distribution of skills <u>within</u> occupation groups at time t_2 as at time t_1, we can estimate

$$S_{i\cdot\cdot}^{t_2:1} = \frac{\sum_{j=1}^{B} N_{j\cdot}^{t_2} S_{ij\cdot}^{t_1:1}}{\sum_{j=1}^{B} N_{j\cdot}^{t_2}} . \tag{8}$$

Second, assuming the same estimate of skill levels for individual jobs (Based on skill estimate 1) at time t_2 as in time t_1, we can estimate:

$$S_{i\cdot\cdot}^{t_2:1} = \frac{\sum_{j=1}^{B} N_j^{t_2} S_{ij\cdot}^{t_2:1}}{\sum_{j=1}^{B} N_{j\cdot}^{t_2}} \quad . \tag{9}$$

Changes in the overall distribution of skills between t_1 and t_2 [(7)-(5)] can then be disaggregated into three components: (1) changes due to inter-occupational group shifts in employment [(8)-(5)]; (2) changes to intra-occupational group shifts in employment [(9)-(8)]; and (3) changes in the estimated skill requirements of particular jobs [(7)-(9)]. Comparing these estimates will illustrate the relative influence of these three factors on changes in the overall distribution of job skill levels in the U.S. economy.

Sources of Data. Two types of information are required to produce the estimates: information on the skill requirements of individual jobs and information on the distribution of jobs in the economy. The former comes from data collected by the U.S. Employment Service on the characteristics of jobs in the United States, which is compiled in the Dictionary of Occupational Titles (DOT).[11] This information includes estimates of the general skill requirements (General Educational Development - GED) and the specific skill requirements (Specific Vocational Preparation - SVP) of jobs. These estimates represent the skills needed to adequately perform the tasks of individual jobs and are made by government experts who observe workers performing their jobs.[12] In

this study only GED was examined, since it relates primarily to general training acquired in school. Separate estimates of individual skill requirements were obtained from two editions of the DOT: the 3rd edition issued in 1965 and the 4th edition issued in 1977.

Information on the distributions of jobs comes from Census data. Two census surveys were used in the analysis: the 1960 1/1000 Public Use Sample and the 1976 Current Population Survey. These two years provide a good period of comparison - 1960 marked the beginning of both an economically prosperous decade and one of rapid growth in the educational attainments (skills) of the work force, while 1976 provides a good point to assess the contemporary situation.

The major methodological task consisted of producing estimates of skill requirements for individual Census occupation codes based on DOT information. The task was difficult, since two different occupational coding systems are used in the two data sources. The U.S. Employment Service uses roughly 13,000 individual job categories, while the Census Bureau uses fewer titles and a classification system based on the socio-economic status of different jobs. The problem was overcome by utilizing other Census data, the 1966 and 1971 Current Population Surveys (CPS), where respondents' occupations were coded under both systems.

DOT information was assigned to 1960 Census data with the aid of a matrix that cross-references Census and DOT occupation codes from the October 1966 CPS. With this matrix and data on the characteristics of jobs from the 3rd edition of the DOT, Lucas assigned to every Census code the probability of having a particular skill (GED) level.[13] These estimates were assigned in turn, to individuals in the civilian labor force 14 years old and over from the 1960 Public Use Sample.[14]

A similar set of procedures was employed in constructing the 1976 data set. In this case Census and DOT occupation codes were cross-referenced using the April 1971 CPS.[15] Another cross-reference was used to supply information from both the 3rd and 4th editions of the DOT.[16] As a result, each valid respondent in the March 1976 CPS was assigned the probability of holding a job requiring each level of GED based on both the 3rd and 4th editions of the DOT.[17]

The two resulting data sets were used to estimate changes in the distribution of job skills between 1960 and 1976. Although originally both the employed and unemployed were included in the two files, the analyses were performed on just the employed population. It was felt that this would give a more accurate picture of the jobs that actually exist in the U.S. economy than would result by including information on the jobs previously held by the unemployed.[18]

Sources of Error in the Proposed Estimates. In several places during the construction of the data files, potential sources of error or bias were introduced. Both the 1960 Public Use Sample and the 1971 CPS files respondents who failed to report an occupation were dropped from the analysis. And in the 1971 CPS, Census coders were sometimes unable to assign a DOT code based on the respondent's job information. These cases were also dropped. It is difficult to assess the degree of this bias, yet there is no evidence to indicate that the errors should not be random. Also, since the procedures used to estimate skill requirements were the same for the 1960 data set as for the 1976 data set, any resulting bias should be similar. Comparisons between the two years should, therefore, accurately reflect actual changes.

A second source of bias comes from using the same estimate of individual skill levels for whites and blacks, men and women. Producing one distribution of job requirements for each census code and assigning it to all individuals with that code will overstate the characteristics of jobs held by blacks to the degree that blacks hold "worse" jobs or lower-skilled jobs than whites, even within the same census job category. This bias is probably weaker for women since the majority are employed in jobs dominated by women.

An additional source of bias in the estimates arises from making comparisons between 1960 and 1976 using the 3rd and 4th editions of the DOT. The information on job characteristics from the 3rd edition of the DOT was released in 1965 and was probably collected in 1963 and 1964. Assigning GED levels to census occupation codes in 1960 based on that edition of the DOT overstates (understates) the actual skill requirements of jobs in that year to the degree that they were lower (higher) than in 1963 and 1964. This problem is less acute in the 1976 data file since the 4th edition DOT information on job characteristics was collected close to the time of the March 1976 CPS. The bias in the 1960 data also means that comparisons or changes in skill requirements between 1960 and 1976 may be understated (overstated).

Finally, there may exist errors in the estimates of skill requirements in the DOT itself. It is fundamental to this study that the skill requirements of jobs be determined independently from

the educational attainments of workers occupying those jobs. There may be a distinct difference between the functional or performance requirements of jobs and the hiring requirements of jobs dictated by employers. Differences in estimated skill levels should measure changes in skill requirements of particular jobs and not changes in employers' tastes for certain worker traits. From a review of the procedures that the U.S. Employment Services used to estimate the skill requirements of jobs, it appears that information on functional requirements of jobs is collected separately from employer requirements[19] But because a number of techniques are employed by job analysts to obtain information on jobs, there is no guarantee that recorded GED levels are completely independent from employer preferences. In this study, however, it is assumed to be the case.

EMPIRICAL RESULTS

Changes in the distribution of skill levels depend upon both changes in the distribution of employment (or jobs) and changes in the skill levels of individual jobs. Table 1 shows the distribution of employment in the United States in 1960 and 1976 within major, Census occupational categories. The Census classification system is the most widely used and well-known system for reporting employment patterns in the U.S., so it will be used as a basis for examining shifts in employment.

Between 1960 and 1976 the percentage of "white-collar" and service workers increased while the percentage of "blue-collar" and farm workers decreased. The growth in "white-collar" employment itself is often

heralded as an indication of the increasing employment opportunities in the more rewarding and demanding portion of the job hierarchy. But the terms "white-collar" and "blue-collar" are really void of any meaning regarding job content or requisite job skills. As Aronowitz states:

> ..."white-collar" is a label that presupposes an essential difference between the structure of labor in the factory and the office. It is a category of social ideology rather than of social science and has evoked the image of a system of social stratification that regards office work as a higher-status occupation than factory work, administration as more prestigious than manual labor, or , indeed, any occupation related directly to the production of goods. The bare fact is that "white-collar" is less a description of an actual group of workers than a conceptual tool for a specific perspective on social class.[20]

In reality some "blue-collar" jobs may require far more skills than many "white-collar" jobs. Thus changes in the distribution of employment among Census job categories may not affect the overall distribution of job skill requirements.

This point is further illustrated by examining estimates of skill requirements (as reflected by GED levels) for jobs <u>within</u> major, Census occupational groups [based on equations (2) through (4)].[21] Table 2 shows the distributions of skill requirements within each group for 1960 based on the 3rd edition of the DOT, and for 1976 based on both the 3rd and 4th editions of the DOT. The table reveals the variation of job

skills both between and within major occupational groups. Within each group there is a distribution of requisite job skills that reflects the varying composition of jobs within each group. This points out why simply referring to professional jobs, for example, as highly skilled jobs ignores the fact that there is a fairly wide range of jobs within this category, requiring a wide range of job skills.

There are also major differences in the distributions of job skills between major groups. The professional/technical group is well represented in high skilled categories (GED levels 5 and 6), followed by the managerial group. But over half of managerial jobs require only middle levels of job skills (GED level 3 and 4). Farm and craft jobs have the next highest distributions of job skills. Clerical and sales occupations, included in the Census' "white-collar" group, occupy predominately the middle range of job skills. Finally, operatives, service workers, and laborers hold jobs in the middle and lower ranges of the spectrum of job skills. These distributions also illustrate how many "blue-collar" jobs do, in fact, require more skills than some "white-collar" jobs, especially clerical and sales jobs.

Changes in the distributions between 1960 and 1976 reflect two factors, the first being shifts in employment within each category between 1960 and 1976. Since each occupational group is composed of a number of individual occupations, changes in relative employment among these occupations can result in changes in the distribution of skills within each group. Comparisons of GED levels between 1960 and 1976 based on the same edition of the DOT illustrate these shifts. This assumes no changes in the DOT estimates of skill requirements of individual jobs.

The second factor is due to changes in the skill requirements of individual occupations. Given a constant job structure within each occupational group, skill requirements for individual occupations will be altered due to changes in technology or the structure of job tasks. Recall that respondents in the 1976 data file were coded with GED estimates based on both the 3rd and 4th editions of the DOT. As a result, changes in the distribution of GED levels for the same year, 1976, based on different editions of the DOT reflect simply changes in the skill levels of individual jobs.

Both changes in employment patterns and changes in skill requirements occurred between 1960 and 1976. However, changes in employment patterns produced only slight changes in the distribution of skill requirements within any of the major occupational categories. There were substantial changes, on the other hand, due to revisions in the DOT estimates of skill requirements. Most important, there was a decline in the percentage of the highest skilled jobs (GED level 6). In both the professional/technical and managerial categories there were significant decreases at this level (from 23.6% to 19.5% in the former and from 14.9% to 5.3% in the latter). This result is quite surprising. It may reflect an increasing proletarianization of managerial and professional occupations that some critics say results in a division of the most complicated and skilled jobs in the economy into lower-skilled components.[22] Although there was a reduction of skill requirements at the highest level, there were increases in skills at the next highest level (GED level 5) within professional and managerial occupations. Sales occupations showed some increase in requisite skills in the middle level (GED level 4) and decreases

in the lower levels (GED levels 2 and 3). All other groups exhibited little change due to revisions in the DOT estimates of skill requirements.

The distributions appearing in Tables 1 and 2 were then used to estimate the distribution of job skills for the economy as a whole [based on equations (5), (7), (8), (9)]. The results appear in Table 3. Column 1 shows the aggregate distributions of skill requirements in 1960 based on the 3rd edition of the DOT [(5)]. Column 2 estimates the distribution of GED levels assuming the same distribution of GED levels within each major, Census occupational group in 1976 as in 1960 and, accounting only for changes in employment among major groups [(8)]. Differences between columns 1 and 2, shown in column 6, provide an estimate of changes in aggregate skill requirements between 1960 and 1976 due simply to inter-group shifts in employment between the two years. Column 3 shows the actual distribution of skill requirements in 1976 based on the 3rd edition of the DOT [(9)]. Differences between columns 2 and 3, shown in column 7, provide an estimate of changes in skill requirements between 1960 and 1976 due simply to revisions in the estimates of skill requirements between the 3rd and 4th editions of the DOT. The overall net differences between the distribution of skill levels in 1960 based on the 3rd edition of the DOT and distribution of skill levels in 1976 based on the 4th edition of the DOT appear in column 5.

With this table it is possible to examine the three components of change that took place between 1960 and 1976:

(1) Inter-occupational group shifts in employment (column 6). This factor confirms the popular notion that shifts in employment have

raised the overall skill requirements of jobs in the economy. The two highest GED levels (5 and 6), which roughly correspond to skills normally acquired in college, increased while the percentage of workers having jobs requiring the lowest four levels (high school or less) decreased.

(2) Intra-occupational group shifts in employment (column 7). This factor did little to change the overall distribution of job skills. There was an increase in the percentage of skilled jobs (GED levels 4 and 5) and a decrease in the percentage of middle level jobs (GED level 3).

(3) Changes in the skill requirements of individual jobs (column 8). This factor showed unexpected results. Revisions in the estimated skill requirements of jobs from the DOT reduced the percentage of highly skilled jobs (GED level 6). There were, however, increases in the percentage of jobs requiring middle skill levels (GED levels 3 to 5).

The net result of these changes (column 5) was to increase the percentage of jobs in the upper-middle range of skills (GED levels 4 and 5). But because of revisions in the DOT estimates of skill requirements, the percentage of jobs at the highest skill level (GED level 6) actually declined, in spite of shifts in employment favoring more skilled jobs.[23] There were also decreases in the percentage of low skilled jobs (GED level 1 to 3).

CONCLUSIONS

The results of this research are perhaps surprising. The overall effects of shifts in the composition of employment in the economy and changes in the skill requirements of individual jobs between 1960 and

1976 resulted in the movement of the aggregate distribution of skills toward the middle and upper-middle and away from the ends of the range. In other words, the distribution of job skills within the U.S. economy apparently "narrowed" during this period. The estimates probably understate the degree of actual change that took place since the 3rd edition estimates of GED levels were made circa 1963 and 1964. The most startling finding was the decrease in the percentage of jobs requiring the highest level of skills, a decrease due solely to revisions in the estimates of skill requirements by the U.S. Employment Service as contained in the 4th edition of the DOT.

The results, however, should only be considered tentative. The methodology of this study was complex and potential biases could have been introduced at several stages. In particular, it was difficult to assign skill requirements to Census occupation codes based on DOT data. Future efforts should be directed toward improving ways of utilizing information from these two rich sources of data.

Additional work is also needed to undertake a more complete, composite analysis of the cognitive and affective requirements of jobs. This study focused on only one dimension of job skills contained in the DOT - GED levels. Future research could utilize other information from the DOT, including information on specific training (SVP) as well as other cognitive and affective traits.

In spite of the limitations of the present research, the results are illuminating. They indicate that the general skill requirements of jobs have changed little over the past decade and a half -- a period of rapid

growth and technological development. This was also a period when the supply of skilled labor, especially college graduates, increased dramatically. As a result, the economic returns to schooling may have declined. On a more fundamental level, the results support the view that recent economic growth and development has flattened the job hierarchy and reduced requisite job skills.

FOOTNOTES

[1]Gary S. Becker, Human Capital (New York: National Bureau of Economic Research, 1964).

[2]Lester C. Thurow, Generating Inequality (New York: Basic Books, Inc, 1975).

[3]Paul Taubman and Terence Wales, Higher Education: An Investment and a Screening Device (New York: McGraw-Hill Book Company, 1974).

[4]Harry Braverman, Labor and Monopoly Capital (New York. Monthly Review Press, 1974).

[5]Carnegie Commission on Higher Education, College Graduates and Jobs (New York: McGraw-Hill Book Company, Inc., 1973); Richard B. Freeman, The Overeducated American (New York: Academic Press, 1976); Russell W. Rumberger, Overeducation in the U.S. Labor Market, (New York:Praeger, forthcoming).

[6]Rumberger, Overeducation.

[7]Carnegie Commission, College Graduates.

[8]R.S. Eckaus, "The Economic Criteria for Education and Training," Review of Economics and Statistics, Vol. 46, No. 2 (May 1964), pp. 181-90; James G. Scoville, The Job Content of the U.S. Economy: 1940-1970 (New York: McGraw-Hill Book Company, 1969; Ivar Berg, Education and Jobs (New York: Praeger Publishers, 1970); Robert E.B. Lucas, "Working Conditions, Wage Rates and Human Capital: A Hedonic Study," Ph.D. dissertation, Massachusetts Institute of Technology, 1972; V. Lane Rawlins and Lloyd Ulman, "The Utilization of College-Trained Manpower in the United States," in Margaret S. Gordon, ed., Higher

Education and the Labor Market (New York: McGraw-Hill Book Company, Inc., 1974). The preceeding illustrate some of the existing research.

[9]Human capital theorists normally assume that increasing the general skill (education) levels of workers will increase their productivity in any job. Several explanations have been offered to account for this. Welch suggests that there is an "allocative effect" to education, meaning that "increased education may enhance a worker's ability to acquire and decode information about costs and productive characteristics of other inputs." (See Finis Welch, "Education in Production," Journal of Political Economy, Vol. 78, No. 1 [January/February 1970], p. 42.) Schultze argues that education enhances a worker's "ability to deal with disequilibria." (See Theodore W. Schultz, "The Value of the Ability to Deal with Disequilibria," Journal of Economic Literature, Vol. 13, No. 3 (September 1975), pp. 827-46.) Others argue that education increases a person's ability to work with capital which, in turn, increases productivity. (See Zvi Griliches, "Capital-Skill Complementarity," Review of Economics and Statistics, Vol. 51, No. 4 (November 1969), pp. 465-68.) But except in the case of agriculture, few of these tenets have been tested empirically.

[10]For example, it is unlikely that employers would or could change the tasks of such narrowly defined jobs as assembly line workers or routine office workers even when highly educated persons apply for those jobs. See discussions by Berg, Education and Jobs, and Braverman, Labor and Monopoly Capital.

[11]U.S. Employment Service, Dictionary of Occupational Titles, 2 volumes, 3rd edition (Washington, D.C.: U.S. Government Printing Office,

1965); U.S. Employment Service, Dictionary of Occupational Titles, 4th edition (Washington, D.C.: U.S. Government Printing Office, 1977).

[12]U.S. Department of Labor, Manpower Administration, Handbook for Analyzing Jobs (Washington, D.C.: U.S. Government Printing Office, 1972).

[13]Lucas, "Working Conditions."

[14]Lucas ("Working Conditions") had information on 295 out of 297 possible codes, leaving some records without information on job characteristics. Lucas also sub-divided two census categories into ten industry subgroups. Instead of using these sub-divided categories, individuals were assigned the mean values of GED from the subgroups within each code. Individuals who failed to report an occupation in 1960 were dropped from analysis.

[15]In some cases respondents were not assigned DOT codes because of missing information. But these turned out to be occupations in which few people were employed (less than .1% of the total sample).

[16]If 4th edition DOT information was unavailable, 3rd edition information was used. But again this affected only a small number of cases.

[17]From the 4th edition of the DOT, only the highest of the three components of the GED scale was used. This corresponded to the single estimate available from the 3rd edition of the DOT.

[18]Of course there are more jobs that exist in the economy than those held by the employed population because, at any point in time, there are a number of vacant or unfilled jobs. But since the analysis focuses primarily on the distribution of job requirements, the actual

numbers are relatively unimportant, although there may be some bias introduced by excluding the unemployed from such analyses.

[19]Department of Labor, Handbook.

[20]Stanley Aronowitz, False Promises (New York: McGraw-Hill Book Company, Inc., 1973), p. 292.

[21]There are 6 GED levels, with 6 representing the highest skill level and 1 the lowest. While the scale does not correspond directly to educational requirements of jobs, a correspondence can be used to illustrate differences. Roughly, GED levels 5 and 6 represent college education, 3 and 4 represent high school education, and 1 and 2 represent elmentary education (Eckaus, "Economic Criteria").

[22]See, for example, Braverman, Labor and Monopoly Capital.

[23]The observed decrease in the percentage of jobs corresponding to GED level 6 is similar to the findings of Berg. Using a different methodology, he constructed distributions of GED levels for the labor force for 1950 and 1960 with the 1950 data based on the 2nd edition of the DOT and the 1960 data based on the 3rd edition of the DOT. Controlling for changes in employment between the two years, he observed a decrease in the skill requirements of jobs at each end of the distribution due to revisions in the DOT. (See Berg, Education and Jobs, pp. 48-49.)

Table 1

Distributions of Employment by Major Census Occupational Groups for the Working Population: 1960 and 1976

OCCUPATIONAL GROUPS	1960	1976
White collar workers	43.1	50.1
Professional and technical workers	11.9	15.2
Managers and administrators	8.6	10.6
Sales workers	7.6	6.5
Clerical workers	15.0	17.8
Blue-collar workers	38.5	32.4
Craft and kindred workers	14.1	12.6
Operatives	19.3	15.2
Nonfarm laborers	5.1	4.6
Service workers	11.6	14.4
Private household workers	2.8	1.8
Other service workers	8.8	12.6
Farm workers	6.7	3.2
Farmers	4.2	1.7
Farm laborers	2.5	1.5
TOTAL (approx)	100.0	100.0

Table 2

Distributions of GED Levels within Major Census Occupational Groups for the Working Population: 1960 and 1976

OCCUPATIONAL GROUPS		GED Levels**					
		1	2	3	4	5	6
Professional workers	1960-3*	0.1	0.4	2.9	16.4	55.9	24.3
	1976-3	0.0	0.4	3.1	16.5	56.2	23.6
	1976-4	0.0	0.4	2.8	10.1	66.9	19.5
Managers	1960-3	0.0	0.9	8.2	47.9	29.5	13.5
	1976-3	0.1	0.5	6.2	45.2	32.8	14.9
	1976-4	0.0	0.6	6.0	51.1	36.7	5.3
Sales workers	1960-3	0.2	0.7	53.5	41.8	3.5	0.5
	1976-3	0.0	0.8	50.4	42.9	4.6	1.1
	1976-4	0.0	6.4	25.4	63.4	4.3	0.2
Clerical workers	1960-3	0.5	2.7	45.3	46.5	4.8	0.2
	1976-3	0.2	2.7	41.1	50.0	5.8	0.4
	1976-4	0.1	2.3	21.7	71.9	3.4	0.3
Craft workers	1960-3	0.4	3.0	24.2	68.7	3.0	0.8
	1976-3	0.2	3.0	24.2	68.0	4.0	0.4
	1976-4	0.1	2.3	21.7	71.9	3.4	0.3
Operatives	1960-3	3.0	30.1	54.9	9.2	0.7	0.2
	1976-3	3.2	35.7	53.3	7.0	0.4	0.1
	1976-4	2.2	36.1	50.3	10.7	0.4	0.1
Laborers	1960-3	12.5	63.7	14.3	4.7	0.5	0.0
	1976-3	12.9	56.4	25.7	4.5	0.2	0.1
	1976-4	5.5	62.7	27.1	4.3	0.2	0.0
Private household workers	1960-3	0.4	12.0	84.8	2.6	2.3	0.0
	1976-3	0.1	11.1	86.3	2.4	0.0	0.0
	1976-4	0.6	10.6	86.4	2.3	0.0	0.0
Service workers	1960-3	5.3	26.0	49.4	18.1	1.1	0.1
	1976-3	5.6	24.7	46.2	21.0	2.0	0.3
	1976-4	7.5	20.2	44.9	25.0	2.1	0.1
Farmers	1960-3	0.7	2.5	5.3	90.9	0.5	0.0
	1976-3	0.3	4.0	7.1	87.6	0.6	0.0
	1976-4	0.2	4.9	6.5	87.3	0.8	0.0
Farm laborers	1960-3	11.7	28.9	53.4	5.5	0.5	0.1
	1976-3	6.3	37.3	47.7	8.1	0.4	0.0
	1976-4	5.5	40.9	44.8	8.4	0.2	0.0

* Year and DOT edition on which distributions are based.
**The total of the 6 levels, summed horizontally, should equal approximately 100.0%.

Table 3

Changes in the Distributions of GED Levels of Jobs for the Working Population: 1960 and 1976

		Distribution of GED Levels			
		1960-3 Actual	1976-3 Predicted	1976-3 Actual	1976-4 Actual
Column		1	2	3	4
GED Levels:	1	2.2	2.1	1.9	1.6
	2	13.5	12.6	13.0	13.2
	3	35.1	33.6	32.2	29.8
	4	33.6	32.5	33.0	35.4
	5	11.0	13.5	14.2	16.1
	6	4.3	5.4	5.4	3.6

		Changes in GED Levels			
		Net Change	Inter-Group Shifts	Intra-Group Shifts	Skill Changes
Column		5 (1-4)	6 (1-2)	7 (2-3)	8 (3-4)
GED Levels	1	- .6	- .1	- .2	- .3
	2	- .3	- .9	+ .4	+ .2
	3	-5.3	-1.5	-1.4	-2.4
	4	+1.8	-1.1	+ .5	+2.4
	5	+5.1	+2.5	+ .7	+1.9
	6	- .7	+1.1	0	-1.8

Column 1 - Distribution of GED levels in 1960 based on the 3rd edition of the DOT
2 - Predicted distribution of GED levels in 1976 based on the 3rd edition of the DOT, assuming the same distribution of GED levels within major, Census occupational groups in 1976 as in 1960 and accounting only for changes in employment among groups
3 - Distribution of GED levels in 1976 based on the 3rd edition of the DOT
4 - Distribution of GED levels in 1976 based on the 4th edition of the DOT
5 - Difference between columns 1 and 4
6 - Difference between columns 1 and 2
7 - Difference between columns 2 and 3
8 - Difference between columns 3 and 4